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ANIMATED SERIAL SECTIONS, A TEACHING AID FOR ORAL HISTOLOGY AND EMBRYOLOGY.

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THE RELATIVE EFFECTIVENESS OF TWO TYPES OF VISUAL MEDIA FOR THE DEVELOPMENT OF A THREE-DIMENSIONAL CONCEPT OF A GIVEN ANATOMICAL REGION WAS INVESTIGATED. EXPERIMENTAL AND CONTROL GROUPS WERE RANDOMLY SELECTED FROM 119 FIRST-YEAR MEDICAL AND DENTAL STUDENTS IN AN HISTOLOGY CLASS. BOTH GROUPS ATTENDED THE SAME ONE-HOUR LECTURE. FOLLOWING THE LECTURE THE EXPERIMENTAL GROUP WAS TWICE SHOWN A FIVE-MINUTE ANIMATED SERIAL FILM THAT HAD BEEN CONSTRUCTED FROM APPROXIMATELY 400 SECTIONS OF HUMAN ORAL TISSUE. THE SECTIONS WERE TAKEN IN AN ORDERLY SEQUENCE FROM THE TISSUE, AND ALTHOUGH TWO-DIMENSIONAL, PRODUCED THE ILLUSION OF THREE-DIMENSIONALITY WHEN SHOWN AS A MOTION PICTURE FILM. THE CONTROL GROUP WAS TWICE SHOWN A SERIES OF FORTY 2 X 2 SLIDES THAT HAD BEEN DEVELOPED FROM KEY SECTIONS INCLUDED IN THE ORIGINAL 400. THE SAME NARRATION WAS USED FOR BOTH PRESENTATIONS. AFTER STUDENTS IN BOTH GROUPS HAD BEEN TESTED FOR ACHIEVEMENT, THEY WERE EXPOSED TO THE PRESENTATION THAT THEY HAD NOT PREVIOUSLY SEEN. FOLLOWING THIS VIEWING, STUDENT REACTIONS TO THE TWO APPROACHES WERE SURVEYED. WHEN ANALYSIS OF VARIANCE WAS APPLIED TO ACHIEVEMENT TEST SCORES, NO SIGNIFICANT DIFFERENCE IN ACHIEVEMENT WAS DETECTED BETWEEN GROUPS OR BETWEEN MEDICAL AND DENTAL STUDENTS. CHI-SQUARE ANALYSIS OF NON-COGNITIVE, ATTITUDINAL ITEMS REVEALED THAT BOTH THE MEDICAL AND DENTAL STUDENTS PREFERRED THE FILM TO SLIDES AS A MEANS FOR (1) STUDYING, AND (2) CONVEYING THREE-DIMENSIONAL CONCEPTS. THE SLIDE GROUP INDICATED THESE PREFERENCES MORE FREQUENTLY THAN DID THE FILM GROUP. (AG)

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ANIMATED SERIAL SECTIONS:

A Teaching Aid For Oral Histology & Embryology

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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An Initial Evaluation of Animated Serial Sections as an Instructional Method for Facilitating Three-Dimensional Awareness of Anatomic Regions[1]

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The development of instructional packages is, at best, a difficult task, and it is not helped by the confusion which surrounds the methodology of evaluation. However, the need for the improvement of instructional technology requires the continual reassessment and updating of educational techniques. The purpose of this report is to describe the testing of a unique method for the visual presentation of anatomic material with improved three-dimensional orientation. The method required the use of colored motion picture film on which were reproduced a sequence of stained, serial sections of the anatomic area under consideration--in this case, a human fetal maxilla.

In using a film so prepared, the time factor allows the development of a desirable illusion of depth. In other words, the film presents, at any one time, a two-dimensional display of some particular plane of the area being studied. But as the film progresses, the plane of presentation moves deeper and deeper so that the observer makes a visual excursion through the block of tissue. In the course of this excursion, his memory of what he has seen previously, coupled with what his eye beholds at the moment, gives him a psychologically integrated concept of depth.

The teaching of three-dimensional relationships in oral histology and embryology, particularly as these relationships relate to an understanding of "differential growth," has long been a problem in medical and dental education.

Moreover, such an understanding is vital for the skilled treatment of congenital malformations, such as cleft palate. This study examines a method for improving the presentation of anatomic material. The successful application of this method benefits not only education in the health fields, but would provide an additional tool for the teaching of the biological sciences in general.

Specifically, it was hypothesized that use of this teaching aid would improve students' ability to grasp the three-dimensionality of anatomic relationships when compared with conventional instruction.

Materials and Methods

Hegre and Brashear (1946) reported their attempts to devise improved methods of instructing students in the concepts of grasping three dimensions. Then Hegre (1951) published his ingenious technique for photographing undistorted serial sections at 2u intervals through small biologic specimens. An example of a specific adaptation of the method to the reaffirmation of the auriculoventricular conduction system in man appeared in 1953 (Read, Hegre and Russi, 1953). However, Hegre's excellent method does not appear to be adaptable to the photographing of large, fetal, term, or postnatal human heads; particularly when they are to be stained differentially with hematoxylin and triosin, or Krichesky's trichrome stain, for greater emphasis. Such large, stained sections of tissue may be mounted on glass and then photographed. The principle of aligning such glass mounted tissue sections has been employed for the production of graphic reconstructions (Hayden and Moore, 1964). Two projectors[3] are used, one for reference, the second for reproduction. The first slide is placed in the "reference" projector to provide an outline upon which a number of sequential sections, placed in the "reproduction" projector, are individually superimposed. The beams of light from each projector are directed to a half silvered mirror, oriented at a 45 degree angle to a screen

and the projectors, thus minimizing errors due to parallax. The image appearing on the screen is photographed. For the film described in this report, approximately 400 sequential serial sections of the head of a term fetus were so aligned and photographed. The image of each section of tissue occupies a few frames in the film and, when projected, is seen on the screen only a short time. The inherent jerkiness of such a film can be smoothened by the use of dissolves, but the jerky film is the more effective in holding student attention.

The animated serial film lasts about five minutes and proceeds anteriorly from the pterygopalatine fossa to the anterior surface of the maxilla. The narration of the film describes the relation of the maxillary, infraorbital and superior alveolar nerves to the developing permanent and primary tooth buds, orbital, nasal and oral cavities, and the minute maxillary sinus. Actually, even the initiated find that this limited description is too much to comprehend at the first viewing. Therefore, a five minute introduction to the general concept of visualizing three dimensions from the examination of serial sections precedes the animation. The introduction presents glass mounted frontal and sagittal sections of the fetal face, and relates them to enlarged plaster models and a fetal head sectioned at centimeter intervals in the frontal plane. Following the introduction, the animation is shown twice. Such is a description of the experimental film.

As a control, 40 sections of tissue were selected from the 400 used for the movie. These sections were "key areas" in the progression from the pterygopalatine fossa to the front of the face. These tissue sections were photographed and mounted as colored 2x2 slides. As in the movie, two identical sets of these slides were projected sequentially, without interruption. The slides were projected from a Kodak Carousel.

To reduce the number of variables in the presentation of the movie and the slides, the same narration was used. A master tape was narrated, then

dubbed into the movie. When the same narration was reproduced on a second tape to describe the slides, the tape was marked with electrical impulses which triggered the Carousel automatically as the narration reached the point where the slide should be changed.

Design and Procedure

The available subjects consisted of first-year dental and medical students at Loma Linda University. Because of class scheduling conditions, the experiment was performed during November, 1965, so that the experimental materials would be relevant to the subjects' class work, but not yet covered in lecture or laboratory. It was decided that it would be important to consider not only a main treatment effect, but also possible differences between medical and dental students, as well as interactions between these two variables of classification. In addition, we decided it would be sensible to examine the attitudes of the subjects toward the film and slide treatments. We decided to examine these non-cognitive variables since our experimental film treatment was short and we were concerned that any feasible achievement test would not be sensitive to possible treatment effects.

Consequently, we developed not only a 22 item achievement test covering the content of the instructional treatments, but also a series of simple questions which asked the subjects to indicate which of the treatments they preferred. The attitudinal questions included a modified form of the Semantic Differential (Osgood, Suci and Tannenbaum, 1957). In addition, the subjects were asked a few procedural questions to ascertain whether they were paying attention and following instructions.

These conditions led us to use the following design and procedure: 132 students came to class at 9:00 a.m. and were given the scheduled one-hour histology lecture. Then they were told they were to be separated into two groups for the next part of the class. They were told to take a ten-minute

break, and that after the break, students with even locker numbers should go to one amphitheater, while students with odd locker numbers should go to another amphitheater. (This amounted to random assignment of subjects to treatment groups since the assignment of locker numbers had been random in nature.) The two amphitheaters were selected on the basis of the smallest degree of difference possible. At the beginning of the sessions, both groups viewed the film introduction to the instructional material. Then the slide group viewed the slide presentation twice and the film group viewed the animated serial section portion of the film twice. After this, both groups took the 22 item achievement test, designed to measure whether or not three-dimensional concepts were obtained, i.e., factual types of items which could have conceivably been answered by listening to the narration alone were not used in deference to items which were spatial in nature. Following the test, the groups were told the other group had viewed another visual presentation, and each group was shown the other treatment. That is, the film group saw the slide presentation, and the slide group saw the film. After both groups had viewed both experimental treatments, the subjects were asked a number of non-cognitive questions concerning their reactions to the two treatments.

Subjects

Of the 132 students who began the study, a few were discarded before the analysis began. Of these, three subjects were eliminated because they were neither medical nor dental students, two subjects were discarded because they did not complete the test booklets, and eight were not included because their performances on the procedural questions indicated they were not paying sufficient attention to the instructions to be acceptable subjects. Thus, the subject pool for analysis consisted of 119 subjects which were partitioned as follows: 35 medical and 28 dental students were placed in the film group; 34 medical and 22 dental students were placed in the slide group.

Results

The analyses were performed in two stages; first the achievement test data were examined, and then the attitude or non-cognitive items were treated.

The initial analysis of the achievement test data was concerned with the selection of a "best" (internally consistent) collection of items to be used as a dependent variable in the analysis. The reliability (internal consistency) of the cognitive test items was investigated in several ways, i.e., coefficient α's using the generalized Kuder-Richardson formula 20 reliability (Cronbach, 1951) were calculated for several sets of items which appeared to yield near maximum α's. These items were, in part, selected on the basis of their loadings on the first principal component obtained from a factor analysis of the 22 test items (Harman, 1960).

For the "most" reliable (internally consistent) set of items, $\alpha = .515$. For the total test, $\alpha = .449$. Since both these sets yield relatively similar coefficients, the results reported below are for the total test, it did not seem fruitful or sensible to complicate the analyses by partitioning the cognitive test.

Thus, to examine for (a) differences between the film and slide presentations, (b) differences between the medical and dental students, and (c) interaction between these two factors, a 2x2 factorial analysis of variance and covariance (Winer, 1962) was performed using the total scores on all 22 test items as the dependent variable. Non-cognitive items which had significant correlations with the dependent variable were used as independent variables in the covariance analysis. These items asked the subjects how well they could visualize in three dimensions and how fair they thought the test was.

The results of these analyses were contrary to our hopes, but consistent with many of our expectations.

Insert Tables 1 and 2 about here

The analyses of variance on the achievement data (see Table 1) displayed no significant differences between the instructional treatments. Furthermore, no significant differences between medical and dental students' performances were found; there was no significant interaction between the treatments and the medical-dental classification. (See Table 2 for means and standard deviations of the dependent variable under the four experimental conditions.) It should be remembered, however, that the dependent variable was not very reliable. In other words, at least two interpretations of the nonsignificant F's are possible: (a) there really are no differences, or, (b) differences exist, but are masked by large standard errors of measurement. (For the achievement test, with the highest possible score being 37 points, the standard error of measurement was 3.462 points.) Taking the various non-cognitive items into account via the analysis of covariance did not change the results; i.e., again, no significant differences were found.

Insert Table 3 about here

The results for the attitude items, however, were consistently positive. Chi-square analyses (see Table 3) were performed on several items; and for several others, simple descriptive information was obtained. The results supported the following conclusions:

1. All groups preferred the film to the slides as a means of providing a feeling for three dimensions.

2. All groups preferred the film to the slides as a studying technique.

3. Students who received the slide treatment tended to prefer the film (over the slides) as a studying technique, more than the students who received the film treatment did.

4. Students who received the slide treatment tended to prefer the film (over the slides) in terms of providing a better feeling for three dimensions, more than the students who received the film treatment did.

To detect whether or not there was a preference for either the film or slide treatment in terms of amount of study time devoted to each, a t test on difference scores (difference between minutes the subjects were asked to allocate to the film and slides for study) across subjects was performed. The obtained t, 1.541, was in the predicted direction, but was not significant ($p < .10$).

A high, negative r of -.444 was found between the total test score and the following item: "Some people are better than others in visualizing in three dimensions. This characteristic does <u>not</u> seem to be related to intelligence. How good are you at visualizing in three dimensions? (a) Extremely good, (b) Good, (c) Average, (d) Poor, or (e) Extremely poor." This indicates that the better the students thought they were at visualizing in three dimensions, the higher their score on the test. This would suggest that the test was, to some degree, a measure of spatial aptitude.

Discussion

Overall, the results are interpreted as positive. The finding that there is no difference between the two treatments on the cognitive dependent variable is not very surprising, in retrospect, especially considering the care with which the slide presentation was constructed to parallel the film treatment. It is certainly important to obtain immediate cognitive data on the effectiveness of any instructional technique, but we feel the lack of positive results on the cognitive data is not particularly disturbing or destructive. The

treatments were just too short and the cognitive test was just not good enough.

On the other hand, the extremely positive results obtained for the attitude data are very encouraging. These non-cognitive items were set up to allow the students' attitudinal reactions to magnify any possible differences between the treatments--and they seemed to exceed the anticipated results. However, these results should not be overinterpreted. They merely support the conclusion that students would prefer our film to our slide presentation. They may merely reflect a general preference for film presentations and/or they may reflect only a preference which does not relate to other more important dependent variables such as positive and lasting attitude or learning effects. Much more data is required to examine the many other important variables which may relate to the effectiveness of the animated serial section film technique. But this need for further work does not destroy the major finding of this research; the students did prefer the film treatment to the slide treatment, both as an instructional technique and as an aid to developing a feeling for the three dimensional nature of the subject matter.

Summary

The first study in a program investigating an animated film as an instructional package in teaching anatomy is described in this article. More specifically, this paper describes an experiment carried out to investigate whether or not medical and dental students achieve a better feeling for the three-dimensionality of a given anatomical region via animated film, rather than the conventional slide presentation.

A group of 119 medical and dental students at Loma Linda University were randomly assigned to the film and slide treatment groups. Analyses of variance and covariance of achievement test data indicated that no significant differences resulted between the experimental treatments or between medical and dental

students, and that the interaction thereof was negligable.

However, χ^2 analyses of several non-cognitive, attitudinal items clearly indicated that not only did both medical and dental students prefer the film to the slides as a means for (a) studying, and (b) conveying the desired three-dimensional concepts, but that the slide group indicated these preferences more frequently than did the film group.

It was concluded that although the treatments did not produce the desired differences, there was sufficient evidence to suggest that (a) given better and possibly longer films and (b) identifying other important independent variables, as well as constructing more appropriate dependent variables, would lead to experimental situations yielding the desired results.

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Footnotes

[1] Acknowledgment: Computor analysis of data was carried out via Western Data Processing Center at the University of California, Los Angeles.

[2] After September 1, 1966 Dr. Hayden will be associated with the College of Dentistry, University of Iowa.

[3] Kodak, Model 500, Eastman Kodak Co., Kodak Park, Rochester, New York.

Table 1

Analysis of Variance on Achievement Test Data

Source	df	MS	F
Medical-Dental	1	4.929	.223
Film-Slide	1	12.918	.583
Interaction	1	.712	.032
Error	115	21.464	

Table 2

Means and Standard Deviations of the Dependent Variable

Under the Four Experimental Conditions

	Film	Slide
Medical	$\bar{x}$ = 20.143	$\bar{x}$ = 20.971
	s = 4.216	s = 5.018
Dental	$\bar{x}$ = 20.714	$\bar{x}$ = 21.227
	s = 4.413	s = 5.289

Table 3

Chi-square Analyses for Two Attitude Items

Item 1: Suppose you had to take another test, not necessarily similar to the one you just had, but on the same material. Also, you were going to see either the animated portion of the film (serial presentation of tissue cross-sections) or the slide presentation again to study for this test, and you could only choose one. Which would it be?

Treatment Classification	Preference on Item 1	
	Film	Slides
Film Group	34	29
Slide Group	48	8
Total	82	37

χ^2 (overall table) = 13.919 **

χ^2 (marginal) = 17.017 **

Item 2: Which of the two types of presentations of the material gave you the better feeling for the three dimensional nature of the subject matter?

Treatment Classification	Preference on Item 2	
	Film	Slides
Film Group	42	21
Slide Group	90	6
Total	92	27

χ^2 (overall table) = 8.675 *

χ^2 (marginal) = 35.504 **

* Significance at $P < .005$

** Significance at $P < .001$